EOV - HD72 - WGS84

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Abstract

Intended for developers, who are using EOV-WGS84 conversion library. Some of the major steps and constants are defined in nutshell.

1 Introduction

Before getting to coding section, we would like to mention a few words on projection systems. Namely EOV, HD72 and WGS84.

EOV - Egységes Országos Vetületi rendszer A projection system used uniformly for Hungarian civilian base maps, in general, for spatial informatics. Cylinder projection in traversal position. Established in 1972-1975.

HD72 - Hungarian Datum of 1972 Hungarian Geodetic Reference System defines procedures for adjustment of the Hungarian Astrogeodetic Network, and on the IUGG GRS 1967 reference ellipsoid, as written for the deflections of vertical at the Laplace-points.

WGS84 -World Geodetic System The World Geodetic System is a standard for use in cartography, geodesy, and navigation. It comprises a standard coordinate frame for the Earth, a standard spheroidal reference surface (the datum or reference ellipsoid) for raw altitude data, and a gravitational equipotential surface (the geoid) that defines the nominal sea level. It's latest revision is WGS84 last revised in 2004, which will be valid till 2010. Some of it's predecessors are:

- WGS 72
- WGS 66
- WGS 60

2 Environment

Conversion library is written in Ruby programming language. Math library is required for mathematical calculations. Before using this library user should check if they have ruby and math lib on their running environment.

3 EOV - Contants

In this section we describe the results.

3.1 Reference surface

Let

$$a = 6378160.000m$$
$$b = 6356774.516m$$

Ellipsodial Geographic Coordinates are: Φ and Λ

3.2 Projecting sphere

A Gauss-sphere fitted to reference ellipsoid at the normal parallel.
It is used for Gauss-sphere: It's radius $R = 6379743.001m$ and and its spherical geographic coordinates:
ϕ and λ

3.3 Normal parallel

Defined as average of latitudes for Hungary, with ellipsoidal and spherical latitudes below
$\Phi_n = 47.10'00.0000$" $\phi_n = 47.07'20.0578$"

3.4 Origin of geographic coordinates

The Equator and the Greenwich meridian

3.5 Origin of projection

A point on the meridian of site Gellérthegy:
$\phi_0 = 47.06'00$" $\lambda_0 = 0.0'0$"
The plane coordinates are:

- $x_0 = 0.0m$
- $y_0 = 0.0m$

and by computing the ellipsoidal geographic coordinates:
$\Phi_0 = 47.08'39.8174$"
$\Lambda_0 = 19.02'54.8584$"

3.6 Displacement

Origin of the EOV plane coordinates is moved to South-West with respect to origin of projection such that all possible EOV coordinates be positive for Hungary:
$X_{EOV} = x + 200000.000m$
$Y_{EOV} = y + x + 200000.000m$
where x and y are the original coordinates in EOV projection system.

3.7 Scale factor

Factor $m_0 = 0.99993$

3.8 Linear Distortion

Along the y axis: $-7cm/km$
North of Hungary: $+26cm/km$
South of Hungary: $+23cm/km$

3.9 Area Distortion

Along the y axis: $-1.4m2/ha$
North of Hungary: $+4.5m2/ha$
South of Hungary: $+4.5m2/ha$

4 HD72 - Contants

Our base ellipsoid is: *GRS67 (IUHH 1967)*

4.1 The Molodensky-Badekas type transformation parameters

Direction of the transformation is HD72 $\gg$ WGS84

$$
\begin{aligned}
d_x &= +57.01 \\
d_y &= -69.97 \\
d_z &= -9.29
\end{aligned}
$$

4.2 Errors for Molodensky-Badekas type of transformation

- On average horizontal accuracy: 0.40 meters.
- Maximum horizontal error: 1.00 meter.
- Vertial accuracy: being optimized.

4.3 For GPS receivers

In the User Datum function, the da and df parameters can be computed from the shape difference between the GRS67 and the WGS84 ellipsoids and the shift parameters should be rounded to integers as follows:

- $d_x = +57$ meters.
- $d_y = -70$ meters.
- $d_z = -9$ meters.
- $d_a = -23$ meters.
- $df = -10^{-8}$ meters.

4.4 The Bursa-Wolf type transformation parameters

Direction of the transformation: HD72 $\gg$ WGS84

- $d_x = +52.684$ meters.
- $d_y = -71.194$ meters.
- $d_z = -13.975$ meters.
- $e_x = +0.3120$ arc seconds.
- $e_y = +0.1063$ arc seconds.
- $e_z = +0.3729$ arc seconds.
- $k = +1.0191$ ppm
- Rotation convention: Coordinate frame rotation (most GIS packages use this one).

4.5 Error for Bursa-Wolf type of transformation

Average accuracies:

- Average horizontal accuracy: 0.19 meters.
- Maximum horizontal error: 0.41 meters.
- Vertical accuracy: optimized.

Notice: Several 7-parameter sets can be defined with almost this accuracy, but take care of the signs of the parameters and the rotation convention.

4.6 Bursa-Wolf Type

In our case, Bursa-Wolf Type transformation have been implemented.

5 Usage - I/O

Usage can be found in rdoc html documentation generated by rdoc.

6 References

Thanks to TIMÁR GÁBOR (timar@ludens.elte.hu) associate professor, head of Geophysics and Space Science Department, without his help and reference materials and sample application "bajnok.xls" aka "champion excel sheet", we could not accomplish the conversion module.

Homepage: http://sas2.elte.hu/tg/